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The Effects of Four Training Programs on the Acquisition of Speed and Accuracy in Motor Performance.

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THE EFFECTS OF FOUR TRAINING PROGRAMS ON THE ACQUISITION OF SPEED AND ACCURACY IN MOTOR PERFORMANCE

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by
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ABSTRACT

The purpose of this study was to determine the effects of four training programs on the development of velocity and accuracy in motor performance when accuracy alone was stressed and when speed and accuracy were stressed. A second purpose of the study was to determine the relationship between performance and strength of the muscle groups involved in the motor skill.

The subjects in this study were one hundred male students enrolled in physical education classes at the University of Southwestern Louisiana, Lafayette, Louisiana.

The subjects were tested initially for accuracy in the one-hand push shot in basketball and for speed and accuracy in passing a basketball at a target. Strength measures were obtained for wrist palmar flexion, combined palmar flexion-arm extension, and in a two-hand push exercise.

The subjects were randomly assigned to four groups of twenty-five subjects each. Each group performed thirty shots for accuracy, and thirty passes at a target for both speed and accuracy each day, three times per week for five weeks.

Group A trained with a regulation basketball; Group B used the regulation ball and supplementary isometric exercises; Group C used a basketball weighing twice as much as the regulation basketball; and Group D trained with the heavy basketball and isometric exercises.

At the end of the training period, the tests for accuracy, velocity and accuracy, and strength were again administered.

The data were analyzed for significance of the gains of each group in each variable. Analysis of covariance with orthogonal comparisons were used to determine the effects of: the type of ball used in training; the isometric exercises, and the interaction between the type of ball used and exercises. Coefficients of correlation were computed to determine relationships among the variables.

The main findings in this study were:

1. In shooting accuracy, subjects in the two groups practicing with the regulation ball improved significantly, whereas subjects who trained with the heavy ball did not. Further analysis revealed that the difference was due to the ball used and not to the effects of the exercises, nor any interaction effect.
2. No significant improvement was made by any group in combined accuracy and velocity scores for the two-hand chest pass.
3. In pa<u>ss</u>ing velocity, the group practicing with the regulation basketball along with supplementary isometric exercises, and the group using only the heavy basketball in training showed significant improvement. No significant gains were made in passing accuracy.
4. Neither wrist palmar flexion strength nor combined palmar

flexion-arm extension strength were significantly related to shooting accuracy.

5. A significant correlation was found between passing accuracy and passing velocity.

The following conclusions were made:

1. Apparently, the strength of the muscle groups involved is not a significant factor in accuracy in a motor skill when the skill is performed within normal distances and when using an object whose weight is commensurate with the capabilities of the average performer for whom the skill is intended.
2. Shooting accuracy in basketball is best improved when the subject practices with the regulation basketball. The use of a weighted basketball and/or the use of supplementary exercises does not result in basketball shooting improvement.
3. Accuracy in a motor skill is not easily improved through practice when velocity and accuracy are both stressed. There is a tendency for the velocity set to dominate the accuracy set.
4. Passing velocity can be increased through practice with a basketball weighing approximately twice as much as the regulation ball, and through practice with a regulation ball along with supplementary strength exercises.

CHAPTER I

INTRODUCTION

Players, coaches, and physical educators are constantly striving to improve performance in activities.

> In the field of physical education and athletics, the unskilled and the skilled, the coach and the physical educator have a common interest--improved performance in sports skills.[1]

During the past years, professional workers in the field of physical education have produced a tremendous amount of information through research that has been of great value in organizing and promoting purposeful programs of physical education. As a result of many of these investigations, new problems have arisen which have been provocative in stimulating further research. Only through knowledge of functional relationships that might exist between certain motor skills can we proceed with reasonable assurance in developing and maintaining progressive programs of physical education, especially in the area of motor performance.

It is significant to note here that physical education, as a profession, has not contributed its share of research in one of its most fundamental areas--motor learning. As noted by the Research

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[1]American Association of Health, Physical Education and Recreation, Research Methods Applied to Health, Physical Education and Recreation. Revised edition. (Washington, D.C., 1952), p. 219.

Council of the American Association for Health, Physical Education and Recreation, most of the motor learning principles employed in physical education have been borrowed from other areas of motor learning research such as typewriting, piano playing, industrial trade skills, and animal laboratory experiments.[2]

It has been generally recognized that the acquisition of motor skills is a phenomenon related in a large degree to the specific task which is practiced.

In movements requiring fineness of coordination and accuracy, the investigators have in the past observed that performance at times appeared to be facilitated when the performers made use of objects somewhat heavier than those he had employed in his regular practice.[3]

Trackmen frequently train using added weights around the waist or extremities in hope of better performance in sprints and jumping activities. Likewise, javelin throwers and shot put performers have been observed practicing with implements heavier than those utilized in competition.

It should be apparent from this discussion that it is essential, from a professional standpoint, that people in the field of physical education must continue to employ scientific techniques and methods to keep pace with modern principles of learning and seek to discover

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[2] Ibid., p. 39.

[3] Glen Egstrom et al., "Acquisition of Throwing Skill Involving Projectiles of Varying Weights," Research Quarterly, 31:420-425, October, 1960.

and utilize those methods of practicing motor skills that will result in positive development of the performers.

I. PURPOSE OF THE STUDY

The purpose of the study was to determine the effects of four training programs on the development of velocity and accuracy in motor performance when accuracy alone was stressed and when speed and accuracy were stressed.

A second purpose of the study was to determine the relationship between performance and strength of the muscle groups involved in shooting for accuracy and passing for speed and accuracy.

II. DELIMITATIONS OF THE STUDY

The study was limited to a nine-week period of investigation involving freshman male students enrolled in the required physical education program at the University of Southwestern Louisiana, Lafayette, Louisiana.

Subjects participating in the study were requested not to participate in any other motor performance activity during the study; however, it was not possible for the investigator to control the activity of the participants after school hours.

III. DEFINITION OF TERMS

Shooting accuracy. Shooting accuracy was defined as the consistency with which subjects put the basketball through the basketball goal, measured by number of successful shots made out of sixty attempts.

<u>Passing accuracy</u>. Passing accuracy was defined as the distance measured in centimeters, a two-hand basketball chest pass deviated from the center of a target.

<u>Passing velocity</u>. The rate of speed of the basketball being thrown from a distance of twenty-five feet. The timer started when a microswitch was energized when the ball was sixteen feet from the target and stopped when the ball struck the target.

<u>Regulation basketball</u>. A Voit basketball of regulation size and weight. The weight of this basketball is 610 grams (1.34 pounds) and the size is 29.5 inches in circumference.

<u>Heavy basketball</u>. A Voit basketball of regulation size but weighing almost exactly twice as much (1206 grams, 2.66 pounds) as the regulation ball.

<u>Group A</u>. This term denotes the group of twenty-five subjects who utilized only the regulation basketball in the training program.

<u>Group B</u>. Group B consisted of twenty-five subjects who utilized a basketball of regulation size and weight, and performed three isometric exercises during the training program.

<u>Group C</u>. This term identified the group of twenty-five subjects who practiced with the heavy ball during the training program, but utilized no supplementary exercises.

<u>Group D</u>. This term pertained to the twenty-five subjects who practiced shooting and passing the heavy basketball and also performed three isometric exercises in the training program.

Group tasks. The term identified the tasks which each group performed. The tasks consisted of the one-hand push shot for accuracy and the two-hand chest pass for speed and accuracy.

CHAPTER II

REVIEW OF THE LITERATURE

For the purposes of this study the review of the literature was divided into three categories. One of the categories includes studies related to throwing accuracy, one category involves studies related to accuracy in basketball shooting, and the other category includes studies related to speed and accuracy.

I. STUDIES RELATED TO THROWING ACCURACY

Egstrom and associates[1] conducted a study utilizing fifty-six college students to determine if there were differences in the degree to which accuracy in throwing with the nonpreferred hand was developed when practice with projectiles of varying weights was used during the learning period. The effects of transfer of learning from the throwing of a ball of one weight to performance with a ball of another weight was also studied. The results indicated that practice with a light ball was as effective as practice with a heavier ball in developing skill to throw a heavy ball. Practice with the heavier ball when transferred to the lighter ball did not demonstrate any corresponding effects upon accuracy.

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[1]Glen Egstrom, Gene Logan and Earl Wallis, "Acquisition of Throwing Skill Involving Projectiles of Varying Weights," Research Quarterly, 31:420 (October, 1960).

II. STUDIES RELATED TO ACCURACY IN BASKETBALL SHOOTING

Varied basket sizes. Maaske[6] investigated the effect of practice in shooting at small baskets on accuracy measured by shooting at baskets of official size. Throughout the basketball season, the small-basket group practiced shooting at the fifteen-inch diameter baskets. The official-basket group practiced shooting at the official basket which is eighteen inches in diameter. At the beginning and the end of the testing period, all players were given a shooting test consisting of four hundred fifty attempts at an official basket from nine different shooting stations. During each practice session, players were allowed about twenty-five minutes in which to practice shots of the type to be used during the season games. A record of all shots attempted and made were kept for two seasons.

Results showed that both groups made significant gains at the one per cent level in shooting accuracy. Analysis of co-variance showed that the improvement in shooting accuracy for the small-basket group was significantly greater (at the five per cent level) than improvement in shooting accuracy for the official-basket group. Further analysis showed that the greatest difference in the improvement in accuracy occurred on shots taken from the stations farthest

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[6]Paul M. Maaske, "The Effect of Practice of Shooting at Small Baskets on the Accuracy of Shooting in Basketball" (microcarded Master's thesis, University of Iowa, Iowa City, 1960).

In experimenting with children from three to six years of age, throwing at a moving target, Hicks[2] found that there were approximately twice as many throws below the center of the target as there were above the center of the target.

Lindeburg and Hewitt[3] used twenty-six experienced basketball players in a study to determine the effect of an oversized basketball on shooting ability and ball handling. It was found that a basketball that is two ounces heavier and one and one-fourth inches larger in circumference than a regulation basketball would have no appreciable effect on the basketball skills of shooting and ball handling.

In two separate experiments, Mace[4] attempted to verify the hypothesis that efficiency in accuracy depends upon the extent to which the target size is modified. The first experiment was an aiming test. Three targets of different sizes were employed. Based on practice scores made on the trial target, twenty students were divided into two groups. Results of the study showed that the group practicing with the small target was superior over the large target group.

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[2]J. A. Hicks, "The Acquisition of Motor Skills in Young Children: An Experimental Study of the Effects of Practice in Throwing at a Moving Target" (Ph.D. thesis, The State University of Iowa, 1931).

[3]Franklin A. Lindeburg and Jack E. Hewitt, "Effect of an Oversized Basketball on Shooting Ability and Ball Handling," Research Quarterly, 36:164, October, 1960.

[4]A. Mace, "The Influence of Indirect Incentives Upon the Accuracy of Skilled Movements," British Journal of Psychology, 22:101-134, October, 1931.

Mace's second experiment involved a two-part dartboard test. In the first part, a single dartboard with a radius of ten inches was used, with circles marked in inches. Two matched groups were used. One group practiced dart throwing from a distance of 2.5 yards while the other group practiced from a distance of 5 yards. Mace assumed that these positions were analogous to those imposed by variations in target size. Accuracy was approximately the same for both groups for the first three test periods, however, after that the "5 yard" group showed marked superiority.

Two dartboards were used in the second phase of the dartboard experiment. Target A had a ten-inch radius, and Target B had a five-inch radius. Each target was divided by ten concentric rings. Darts were thrown from a distance of 2.5 yards for both groups. The findings indicated that the small-target group, Group B, was superior to Group A, the large-target group. In only five of the forty practice periods was the large-target group more accurate than the small-target group.

Day,[5] in a study similar to the study conducted by Mace, agreed with the findings. He found that accuracy of aim increased using a small target over a large target.

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[5]R. H. Day, "The Effect of Size of Target on Accuracy of Aim," American Journal of Psychology, 67:659-667, 1954.

(twenty-three feet) from the basket. Maaske suggested that this was a reflection of the fact that, for a given angle of error, the distance by which a shot misses the center of the basket varies directly with the distance from the basket to the spot from which the shot was taken. Thus, increased accuracy in shooting is more critical to success in shooting long shots than in shooting short shots.[7]

Kite,[8] studying the effects of variation in target size and two methods of practice on the development of accuracy in a motor skill, found that all groups showed significant gains in shooting performance, but shooting at baskets of varying sizes during the practice period failed to cause any significant differences in the mean gains of the four experimental groups.

Visual cues. Anderson[9] tried to determine whether the use of visual aids would significantly improve the teaching of bank shots in basket shooting. The experimental group used a backboard marked with black dots as the point of aim, while the control group practiced without the aid of these spots. Anderson concluded that use of the visual aids did significantly improve shooting accuracy while the plain backboard did not.

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[7] Ibid.

[8] Joseph C. Kite, "The Effects of Variations in Target Size and Two Methods of Practice on the Development of Accuracy in a Motor Skill" (unpublished Doctoral dissertation, Louisiana State University, August, 1964).

[9] Theresa Anderson, "A Study of the Use of Visual Aids in Basket Shooting," Research Quarterly, 13:532-37, 1942.

Hertz[10] used three groups of twenty subjects concerning the effectiveness of three different methods of learning to shoot free throws in basketball. Group I used the center of the basket as the point of aim. Group II used mental practice and visual imagery while Group III employed the kinesthetic method. The specific objective was to try to determine whether a method of practice could develop the subjects' ability to recognize the amount of force and angle of projection necessary to make a clean shot. Group III practiced shots daily at a spot on the floor, that if it hit the spot in a designated number of seconds, it resulted in an arc of flight which would cause the ball to pass cleanly through the basket. This procedure paralleled that used by Mortimer.[11] All three groups showed significant improvement, however, no significant differences existed between the means of the groups.

In a study which investigated the effectiveness of a mental practice method, demonstration method, and a kinesiological method which all included practice without a basket, Halverson[12] concluded that all three methods proved effective in the development of motor skills. The mental practice method was not as effective in the

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[10]Gilman Hertz, "The Effectiveness of Three Methods of Instruction in One-Hand Foul Shooting" (microcarded Doctoral dissertation, University of Indiana, Bloomington, 1956).

[11]E. M. Mortimer, "Basketball Shooting," Research Quarterly, 22:234-43, May, 1951.

[12]Lolas E. Halverson, "A Comparison of Three Methods of Teaching Motor Skills" (microcarded Master's thesis, University of California, Berkeley, California, 1944).

development of motor skill as the other two methods, however, the kinesiological method proved as effective as the demonstration method in the total group scores and more effective in the results of the subjects with low pre-test scores.

Noble,[13] in a study involving different sessions of shooting basketballs, found that there was no particular advantage to be gained by a group using four ten-shot sessions per day over a group using two twenty-shot sessions each day. One method was not better than the other.

Griffith[14] conducted a study in which the subjects shot ten baskets before and after regular practice for four and one-half weeks. Records were kept of the number of shots which fell too short or too long, or to the right or left. Griffith found, as did Bunn[15] and Oliphant[16] that the missed shots were more frequently caused by errors in distance than errors in direction, and that ordinary practice tended to correct the latter, but not the former. An error to the left or right is quickly seen and compensated for, however,

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[13]Stuart Noble, "The Acquisition of Skill in the Throwing of Basketball Goals," Journal of Applied Psychology, 16:640-44, 1942.

[14]Coleman Griffith, "Types of Errors in Throwing Free Throws," Athletic Journal, 1:22-26, September, 1930.

[15]John W. Bunn, Scientific Principles of Coaching (New York: Prentice Hall, Inc., 1955), pp. 222-26.

[16]Harve A. Oliphant, "A Study of Improvement in Shooting as Related to the Amount of Practice" (microcarded Master's thesis, University of Iowa, Iowa City, 1939).

skill in estimating distance is more difficult to acquire. Results of the study supported the statement in showing that practice increased accuracy, but that all the improvement was due to the correction of direction error and not to correction of distance error. Further analysis showed that distance errors were more frequent after a heavy workout, but players were as accurate after a two hour workout as at the beginning of the workout.

Griffith[17] suggested that players should practice shooting free throws while blindfolded to get the "feel" to correct distance error.

Distance and direction error. Griffith[18] concluded from a study conducted at the University of Illinois that errors in direction were caused by unequal strength in the hands and unequal speed at which applied.

Oliphant[19] investigated the percentage of successful shots from varied distances and concluded that in shooting baskets, the same angle of error in projecting the ball from two distances should result in misses at the basket proportional to the squares of the distance thrown. Thus, there should be approximately four times as many misses from a distance of forty feet as from a distance of twenty feet.

Bunn[20] advocated that all shots should be banked shots. A

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[17]Griffith, loc. cit.

[18]Coleman Griffith, "Experiments in Basketball," Athletic Journal, June, 1929.

[19]Oliphant, loc. cit. [20]Bunn, loc. cit.

tabulation of shooting attempts indicated that more shots fall short than long, probably due to the fact that most players are taught to use the nearest point on the rim as a target. With this as the focus, the distribution of shots will be short of and beyond this point. As players tire, they begin to fall short of their target, therefore, one should emphasize overshooting with the use of the backboard. Bunn related that a study on shooting at a target in the center of the basket showed that scores improved twenty per cent over the aim at the front rim. He also referred to another study which placed spots on the backboard six inches apart and one foot above the rim of the basket showed that players who used the spots improved faster than those who shot at an unmarked board. Those who used spots improved 10.8 per cent after four weeks of practice while those who practiced without the spots improved only 4.4 per cent. Removing the spots later did not affect accuracy. It was hypothesized that the image had therefore been set. According to Bunn, this study also indicated that a four-week practice period was sufficient for optimum results.

Moffett[21] investigated the relative size of the angle of error as a basis of discrimination as to whether or not there are significant differences in accuracy of direction in certain motor skills at different distances. Moffett studied the one-hand push shot which was

[21]D. C. Moffett, "A Study of Direction in Motor Skills at Different Distances as Determined by the Relative Size of the Angle of Error," Research Quarterly, 13:466-479, December, 1942.

administered from distances of ten feet, fifteen feet, twenty feet, twenty-five feet, thirty feet and thirty-five feet. Practice before the start of the period could be taken but not from the distance to be used that day. Subjects completed one hundred trial shots from each distance. Moffett concluded that accuracy in the one-hand push shot increased when the distance was increased from ten to fifteen feet. However, when the distance is increased from fifteen feet to twenty-five and/or thirty feet, a decrease in accuracy results. These statements contradict, somewhat, the findings of Oliphant[22] in a similar study.

Nelson[23] found that it became increasingly difficult to shoot baskets successfully as the distance of the shooter from the basket increased.

McCloy[24] found that in shooting baskets in basketball, the percentage of errors at a distance of twenty feet from the basket was greater than the percentage of errors made from a distance of thirty-five feet from the basket.

Bee and Norton[25] state that shooting a basketball is much like

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[22]Oliphant, loc. cit.

[23]I. L. Nelson, "An Analysis of Goal Shooting Accuracy in Basketball of High School Boys and Girls" (microcarded Master's thesis, University of Iowa, Iowa City, 1939).

[24]C. H. McCloy (unpublished study on Accuracy in Throwing Baskets as a Part of the Game of Basketball).

[25]Clair Bee and Ken Norton, Basketball Fundamentals and Techniques. New York: The Ronald Press Company, Second edition, 1959), p. 27.

firing a rifle, it being important to draw a bead on the target and then concentrate on that point before, during, and after the shot. Bee and Norton believe that almost anyone can learn to shoot, and strange as it seems, people without normal vision oftentimes become expert marksmen.

III. STUDIES RELATED TO SPEED AND ACCURACY

McLeod[26] found that there was a negative correlation between speed and accuracy in performance of motor responses. He suggested that the relationship is a function of the particular movement.

McGeogh[27] attempted to establish the relationship between accuracy and speed. He agreed with some authorities that the optimum procedure is to retard the speed of movement in the early stages of practice until a high degree of accuracy is reached and then gradually to increase speed. Others believed that speed is a part of form and should be emphasized from the beginning of the learning period.

Woodworth[28] found that when working with a "three hold aiming test" speed and accuracy in this relatively simple coordinated movement are inversely related; as the speed increases, accuracy decreases.

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[26] L. S. McLeod, "The Interrelationship of Speed, Accuracy, and Difficulty," *Journal of Experimental Psychology*, 12:431-43, 1929.

[27] John A. McGeogh, "The Acquisition of Skill," *Psychological Bulletin*, 26:470, August, 1929.

[28] F. S. Woodworth, "Accuracy of Voluntary Movements," *Psychological Review*, 13:27-62, 1904.

Van Huss[29] found that accuracy response following warm-up by overload techniques yielded a significant increase in velocity, however, as the speed was increased, the subjects' pattern of throwing was significantly changed.

Fulton[30] using two equated groups attempted to demonstrate the effects of placing emphasis on speed or on accuracy in the initial stages of performing a ballistic movement. One group was instructed to emphasize accuracy and to increase the speed of the swing with the flat surfaced bat only when the accuracy was high. The other group stressed speed from the beginning of the training period. The following results were found:

1. The group emphasizing speed initially, developed accuracy to a greater extent than the group which made accuracy of the stroke the primary aim from the start of the experiment.
2. The total speed of the two groups in the final training period was practically the same.

Eckler, Hullett and Ammons[31] studied the effect of varying rates of firing at targets on performance of an aiming task. Forty-eight male

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[29] W. D. Van Huss et al., "Effects of Overload Warm-ups on the Velocity and Accuracy of Throwing," Research Quarterly, 33:472, October, 1962.

[30] Ruth E. Fulton, "Speed and Accuracy in Learning a Ballistic Movement," Research Quarterly, 13:30, March, 1942.

[31] A. S. Eckler, E. L. Hullett, and R. B. Ammons, "Effects of Practice Conditions on Aiming Skills," Perceptual Motor Skills Research Exchange, 4:43, March, 1952.

college students, all naive to the apparatus being used, were given twenty trials of twenty shots each. The twenty-four conditions of practice were all possible combinations of two rates of firing (twenty and fifty shots per minute), effective target size (fifty-seven and forty-six millimeters in diameter) and three conditioned of rest between each group of twenty shots.

Findings were summarized as follows:

1. Group differences in accuracy due to rate of firing decreases with practice.
2. Group differences in accuracy due to target size decreases with practice.

IV. SUMMARY OF RELATED LITERATURE

In a study particularly pertinent to this investigation, Egstrom and associates[32] found that practice with a light ball was as effective as using a heavy ball in developing skill to throw a heavy ball. Practice with a heavy ball when transferred to the lighter ball did not demonstrate a corresponding effect.

Hicks[33] found that there were twice as many throws below the center of a target as there were above the center of the target.

Lindeburg and Hewitt[34] studied the effects of using an oversized

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[32] Egstrom, Logan and Wallis, loc. cit.

[33] Hicks, loc. cit.

[34] Lindeburg and Hewitt, loc. cit.

basketball on shooting ability and ball handling. The results indicated that the large ball circumference had no appreciable effect on the two skills.

Two authors agreed that accuracy of aim increased using a small target over a large target.

With experienced basketball players, Maaske[35] demonstrated the superiority of practice at a small basket over practice on an official basket in developing shooting accuracy, particularly in shooting long shots. However, with inexperienced subjects, Kite[36] found that practice on varying sizes of baskets yielded no significant difference in gains made in shooting accuracy.

Two authors discovered that accuracy in shooting baskets was improved significantly by players who used spots on the backboard as visual aids when practicing.

Two authors investigated the effects of mental practice on the development of accuracy in basket shooting. Only one author reported that the use of mental practice resulted in significant gains in shooting.

One author found that there was no difference between massed and distributed practice in developing shooting accuracy.

Oliphant, Bunn, Griffith and Nelson[37] found that as the distance

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[35]Maaske, _loc_. _cit_.

[36]Kite, _loc_. _cit_.

[37]Oliphant, Bunn, Griffith, and Nelson, _loc_. _cit_.

of the shooter from the basket increased, the difficulty to shoot baskets successfully also increased. McCloy[38] contradicted these findings slightly in that he found a slight gain in accuracy from twenty to thirty feet from the basket.

Moffett[39] found that accuracy of shooting increased when the distance was increased from ten to fifteen feet, however, when the distance was increased to twenty-five feet or thirty feet, accuracy decreased.

Two authors agreed that speed and accuracy were inversely related. As the speed increased, the accuracy decreased.

McGeogh[40] found that the best procedure to use was to practice until a high degree of accuracy existed then gradually increase speed.

One author somewhat contradicted the findings of McGeogh. Fulton[41] found that a group that emphasized speed initially, developed accuracy to a greater extent than did a group which stressed accuracy from the start of the experiment.

Van Huss[42] found that warming up with a weighted ball significantly increased velocity, but the pattern of throwing was changed.

Three authors summarized that group differences in accuracy in target firing due to variations in target size decreases with practice.

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[38]McCloy, loc. cit. [39]Moffett, loc. cit.

[40]McGeogh, loc. cit. [41]Fulton, loc. cit.

[42]Van Huss, loc. cit.

CHAPTER III

PROCEDURES OF THE STUDY

I. OVERVIEW OF PROCEDURES

Data from one hundred subjects at the University of Southwestern Louisiana were used in this study. The subjects were given an initial test on the one-hand push shot in basketball at a distance of twenty-five feet from the basket, and on the two-hand chest pass for speed and accuracy from a distance of twenty-five feet. In addition, all subjects were tested for arm extension and wrist flexion strength of the preferred arm, as well as strength in a two-hand push exercise performed in the position of the chest pass.

The subjects were randomly assigned to one of four groups for the training program. One group practiced shooting and passing using the regulation basketball; a second group practiced with the regulation basketball and were given supplementary isometric exercises; a third group practiced shooting and passing with a ball approximately twice as heavy as a regular basketball; and the fourth group practiced with the heavy ball and also engaged in isometric exercises.

After the training period of three days per week for five weeks, the subjects were re-tested for accuracy in basket shooting, for speed and accuracy in the chest pass, and the three strength measures.

II. SELECTION OF SUBJECTS

Subjects for the study were selected from students participating in the required physical education program for freshmen at the University of Southwestern Louisiana, Lafayette, Louisiana. Male students were assigned to activity classes by means of computer selection. This manner of selection assured the writer that the subjects participating in the study were of random selection and representative of the total freshman male population at the University.

The subjects were orientated concerning the purpose of the study and the program of training outlined. The writer suggested that any student who was not interested in the study should switch to another non-experimental class at the same hour.

III. GROUPING OF SUBJECTS

The subjects were randomly divided into four groups. Names of the subjects were drawn from a box and placed in Group A, B, C, or D in that order. This procedure was followed for the three class periods. In order to neutralize any possible effects of time of day, ten subjects per class period were selected for each group, making a total of thirty subjects in each of the four groups at the beginning of the study.

As the study progressed, several students dropped from the classes for various reasons, resulting in a total of 109 subjects at the end of the training period. The four groups finally numbered 25, 28, 28, and 28. To facilitate the statistical analysis by use of the computer it was necessary to make the numbers in all the groups the same. Consequently, nine subjects were randomly eliminated from three groups in order for all groups to number twenty-five.

The four groups of twenty-five subjects employed essentially the same tasks. Each group attempted thirty one-hand push shots for accuracy at a basketball goal from a distance of twenty-five feet from the base line and performed thirty two-hand chest passes at a target from a distance of twenty-five feet. Both speed and accuracy were stressed in the passing.

Group A. Subjects in this group used the regulation basketball in the performance of the tasks. This group did not perform isometric exercises.

Group B. Subjects assigned to this group performed three isometric exercises and practiced the shots and passes utilizing a basketball of regulation size and weight.

Group C. Subjects in this group utilized the heavy ball in the training program, but did not perform the isometric exercises.

Group D. Subjects assigned to this group performed three isometric exercises and practiced the thirty attempts for shooting accuracy and the thirty passes for speed and accuracy utilizing a regulation size basketball that weighed twice as much as an official ball.

IV. PRE-STUDY ORIENTATION

Two weeks prior to the beginning of the study each subject was given written detailed instructions on the techniques involved in shooting the one-hand push shot and the two-hand chest pass. (See Appendixes A and B).

The groups were informed that each group would be randomly assigned a different treatment to be employed during the training program.

Each group was made aware of the important contribution their full cooperation might make in the area of motor performance.

The week prior to the administration of the initial shooting and passing tests, all subjects were oriented as to the nature of the study and testing and training procedures. Subjects received verbal instructions, demonstrations, and practice in the mechanics and techniques of the one-hand push shot and the two-hand chest pass.

The subjects were asked to station themselves along an arc twenty-five feet from the base line that had been drawn on the floor with a felt marking pencil. Subjects were advised to begin shooting at the basket, keeping in mind the correct techniques outlined in the written and verbal instructions. The investigator made suggestions and corrections when circumstances warranted. The practice procedures were repeated several times a period for one week.

The two-hand chest pass was also practiced during the orientation sessions. Four practice targets were used in the training period.

The students had been given detailed written and verbal instructions and demonstrations as in the shooting. As the subjects practiced, the investigator gave individual advice and made corrections when necessary. Half the number of subjects practiced the chest pass while the other half practiced the shooting skill. Numerous trials were given in both shooting and passing during the orientation week.

V. TESTING EQUIPMENT

Palmar flexion strength. The instrument used to measure strength of palmar flexion of the preferred hand was the cable tensiometer originated by Clarke and Peterson[1] as shown in Figure 1. The gauge is designed to measure tension exerted on a one-sixteenth inch cable. The cable tensiometer was recorded to the nearest one-half unit and converted to pounds using the calibration chart. The reliability of the instrument was computed by the Pearson Product-Moment of Correlation. The first trial of the first period was correlated with the first trial of the second period. The coefficient of correlation for the one hundred subjects was found to be .92.

Combined palmar flexion and arm extension strength. The strength of palmar flexion and arm extension of the preferred arm was measured by the cable tensiometer. The reliability coefficient computed by the test-retest method was .90.

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[1] H. Harrison Clarke and Kjell J. Peterson, "Strength Tests of Affected Muscle Groups Involved in Orthopedic Disabilities" (unpublished Manuscript, Springfield College, Springfield, Massachusetts, 1945).

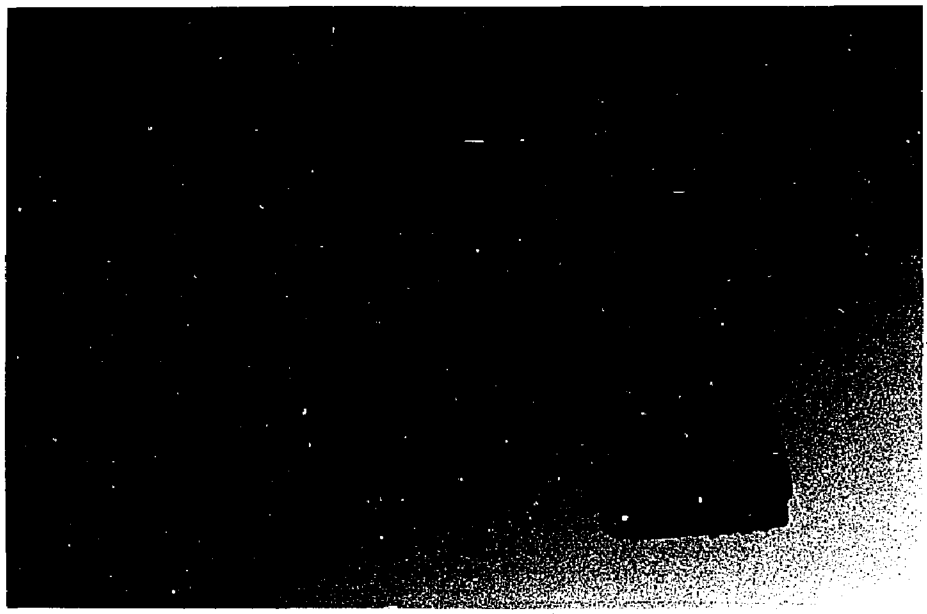

FIGURE 1

TENSIOMETER

Arm push strength. The device used to measure the two-hand push strength in the position of the chest pass was a bathroom scale mounted on an adjustable platform. The reliability of the device was computed by the Pearson Product Moment of Correlation. The first trial of the first session and the first trial of the second session was used in the test-retest relationship. The coefficient of reliability was found to be .88.

Shooting accuracy. Shooting accuracy was measured by the number of successful attempts made with a regulation Voit basketball at a regular basketball goal.

<u>Passing velocity</u>. The instrument used to measure the velocity of the ball in a two-hand chest pass at a target from a distance of twenty-five feet, was the Automatic Performance Analyzer[2] shown in Figure 2. The reliability of the instrument was computed by the Pearson Product Moment of Correlation. The first trial of the first session was correlated with the first trial of the second session and found to be .87.

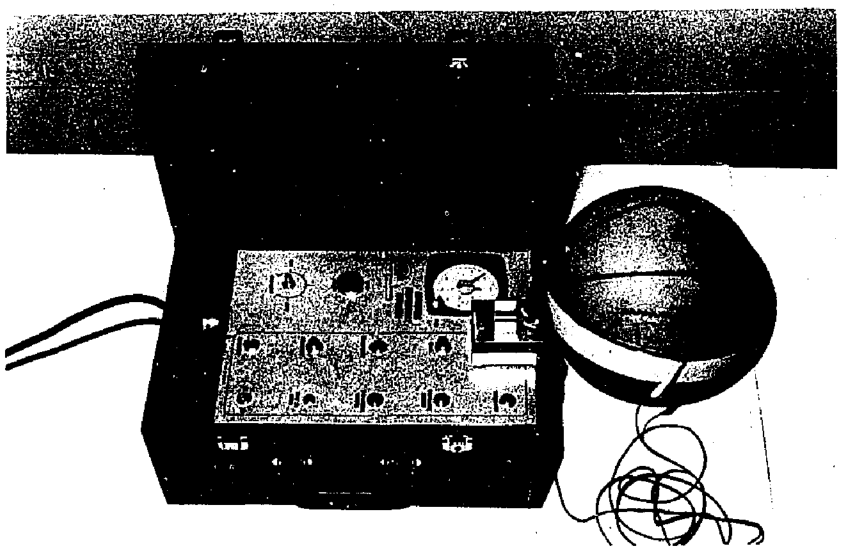

FIGURE 2

AUTOMATIC PERFORMANCE ANALYZER USED TO MEASURE VELOCITY OF THE BASKETBALL IN A TWO-HAND CHEST PASS

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[2]Automatic Performance Analyzer, Dekan Timing Devices, Post Office Box 712, Glen Ellyn, Illinois.

<u>Passing accuracy target</u>. Figure 3 depicts the target used for measuring accuracy in the two-hand chest pass. Both speed and accuracy were measured simultaneously. A four foot square target made of plywood was used. The face of the target was painted black. A center circle with a three and one-fourth inch radius was painted red. This was used as a point of aim. A centimeter tape was attached at the center of the red circle to measure deviations of the ball from the center of the target.

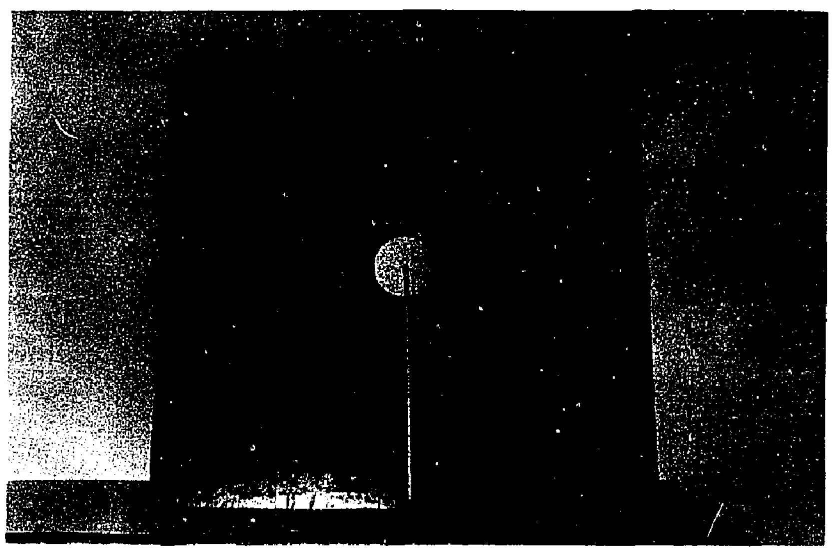

FIGURE 3

TARGET USED TO MEASURE ACCURACY OF THE TWO-HAND CHEST PASS

VI. TESTING PROCEDURES

For purposes of clarity, this section was divided into three areas. The areas consisted of strength testing, shooting tests for accuracy, and passing tests for velocity and accuracy.

Strength tests. Due to the nature of the motor skills being performed, basket shooting and passing, the primary muscles involved in the tasks were believed to be the palmar flexors. Therefore, all three of the exercises practiced during the training period and tested initially and finally concentrated on palmar flexion. One exercise, and the test for it, attempted to involve only palmar flexion; one exercise and test involved palmar flexion along with arm extension; and the third exercise and test was for palmar flexion and other muscle groups exercised in the performance of the passing skill.

During the last day of the orientation week, all subjects were tested on the three strength exercises. Two of the tests were administered on an isometric exercise table, and one test was done in a standing position which simulated the passing position.

The two tests performed on the table were for palmar flexion strength and combined palmar flexion and arm extension. For the test of palmar flexion, the subject assumed a supine position on the table with the elbow and the upper arm flat on the table. The angle between the upper and lower arm was ninety degrees. A handle attached to the cable of the tensiometer was placed on the fingertips of the subject with the wrist in a dorsiflexed position. The subject exerted force by trying to palmar-flex the wrist. The force exerted was recorded on the dial of the tensiometer. A trained assistant held the subject's arm in the proper exercise position. Figure 4 illustrates the exercise and position used. The average of the first two trials was used as the initial score and recorded on the subject's personal data sheet.

FIGURE 4

EXECUTION OF THE WRIST PALMAR FLEXION EXERCISE
USING THE CABLE TENSIOMETER

In the combined palmar flexion-arm extension strength test, it was realized that the amount of force exerted was considerably less than if arm extension alone was measured. Placing a strap on the forearm would have allowed the subject to exert a much greater force because of the greater strength of the arm extensors. However, as was mentioned earlier, it was felt that the importance of the arm extensors was secondary in the shooting and passing skills. Therefore, the investigator desired to exercise the extensors combined with the action of the palmar flexors.

In the performance of the combined palmar flexion-arm extension exercise, the subject assumed a similar supine position utilizing the handle arrangement at the heel of the hand. The upper arm was placed in a position forty-five degrees from a vertical position with the elbow off the table. The angle between the upper and lower arm was ninety degrees. The subject was advised to exert force vertically. A trained helper assisted by holding the subject's hand in the correct plane as shown in Figure 5. The average of the first two trials was used as the initial score and recorded on the subject's personal data sheet.

The subjects were given two trials of an arm push exercise which closely resembled the mechanics involved in the execution of the two-hand chest pass. The subject held a basketball in both hands with the wrists in a dorsi-flexed position and pressed against a bathroom scale mounted on an adjustable platform. Excessive forward or backward lean was not permitted and placement of the feet was left

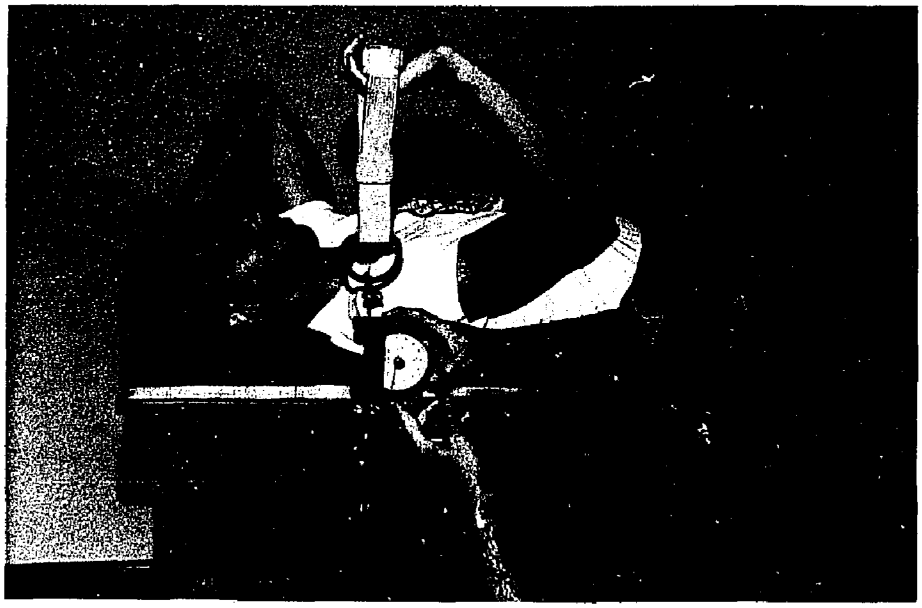

FIGURE 5

EXECUTION OF THE COMBINED PALMAR FLEXION-ARM EXTENSION EXERCISE USING THE CABLE TENSIOMETER

to the discretion of the subject. The foot that was used as the brace foot was placed against a block to aid balance and force exertion. Figure 6 depicts the apparatus and the proper position for the exercise. The force exerted was read from the scale in pounds. The average of the first two trials was used as the initial score and recorded on the subject's personal data sheet.

Shooting accuracy test. During the second week of study, all subjects were given the shooting test for accuracy. Each subject attempted thirty shots at the basket from a distance of twenty-five feet from the base line directly in front of the basket. The test was taken twice and the number of successful attempts out of sixty over the two training periods was considered the initial score.

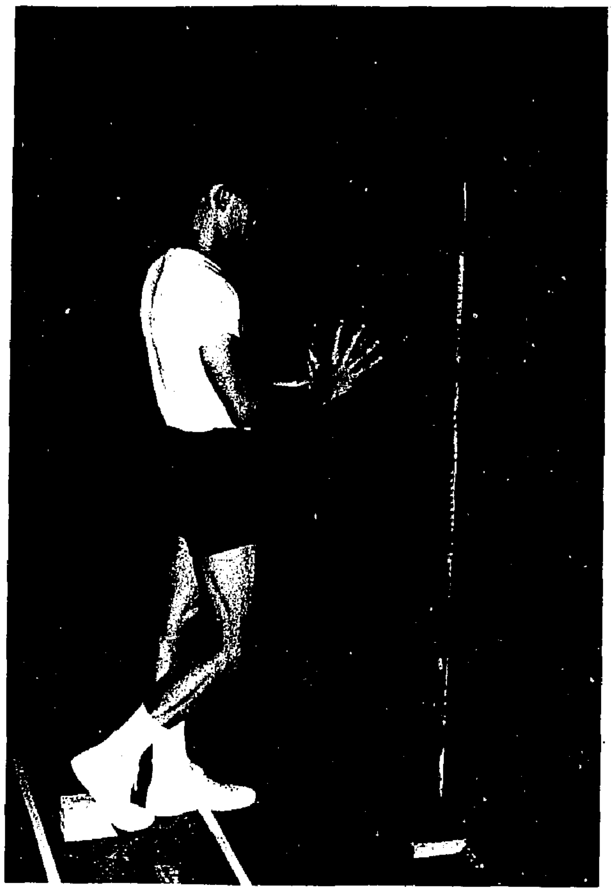

FIGURE 6

DEVICE USED IN THE EXECUTION OF THE TWO-HAND PUSH EXERCISE

Tests for passing velocity and accuracy. Tests for velocity and accuracy of the two-hand chest pass were begun in the second week. A regulation basketball with an eight foot string attached to the ball was used. The unattached end of the string held a small peg which was inserted into the "special start" microswitch of the from the base line directly in front of the basket. The test was taken twice and the number of successful attempts out of sixty over the two training periods was considered the initial score.

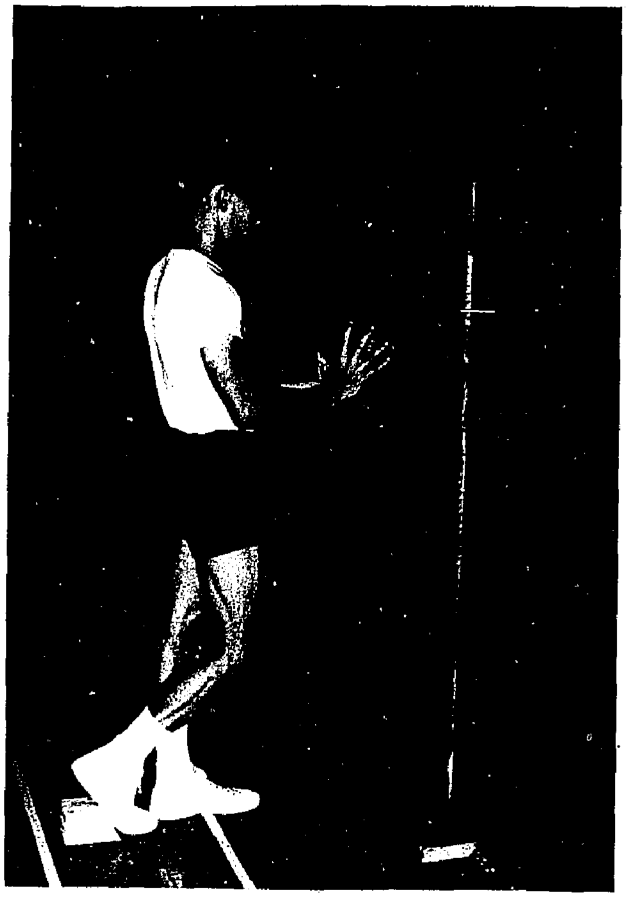

FIGURE 6

DEVICE USED IN THE EXECUTION OF THE TWO-HAND PUSH EXERCISE

Tests for passing velocity and accuracy. Tests for velocity and accuracy of the two-hand chest pass were begun in the second week. A regulation basketball with an eight foot string attached to the ball was used. The unattached end of the string held a small peg which was inserted into the "special start" microswitch of the

Automatic Performance Analyzer. As the ball was projected toward the four foot square target, the peg pulled out at the end of an eight foot line and started the timing device. An impact switch attached to the back of the target board stopped the timing device when the ball struck any part of the target. The velocity of the ball in flight was calculated by multiplying sixteen feet, the number of feet over which the ball was projected, by the time of the ball in flight. The subjects performed the chest pass thirty times. The average deviations from the center of the target and the average velocity scores were computed for the thirty passes and were used as the initial scores for accuracy and velocity. Illustrated in Figure 7 is the target and timing apparatus used in the test.

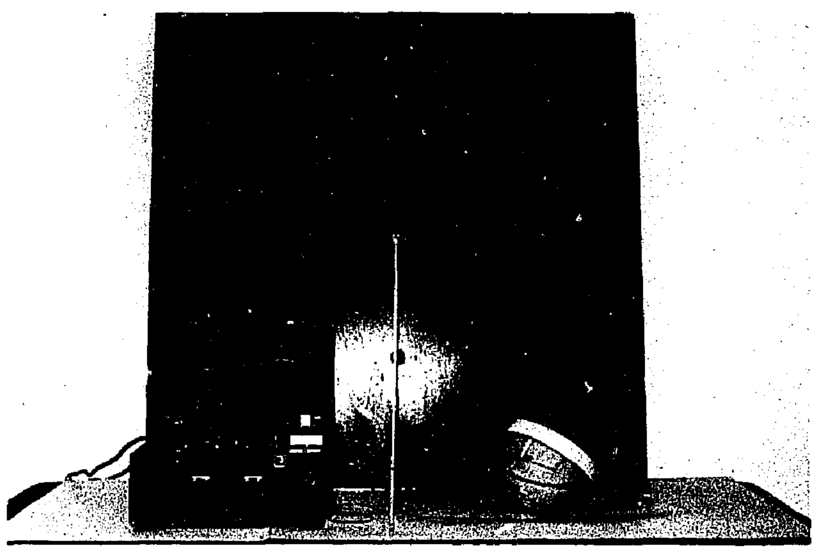

FIGURE 7

TARGET AND TIMING DEVICE USED FOR TESTING VELOCITY AND ACCURACY OF THE TWO-HAND CHEST PASS

At the termination of the training program, the tests were repeated to obtain a final score for the subjects.

VII. TRAINING PROGRAM

Five weeks of actual experimentation began after the two weeks testing period, during which each of the groups practiced according to the treatment assigned them.

At the beginning of the period, the subjects dressed in the standard university physical education uniforms and reported on the gymnasium floor for roll call. After roll call, the groups dispersed to the area assigned them and proceeded to practice the skills as follows:

Groups A and B began performing three isometric exercises. The tensiometer and testing apparatus used in measuring combined palmar flexion and arm extension strength and palmar flexion strength discussed earlier were not used in the training program because of the time involved in adjustments. However, exercises were performed which were designed to exercise the same muscle groups. In the wrist palmar flexion exercise, the subject placed his hand on a handle so that the first two joints of the fingers were in contact with the handle. This handle was attached to a rope secured to a bar on gymnastic parallel bars. With the wrist dorsi-flexed and the arm fully extended, the subject applied his maximum pressure against the handle. This position was held for a duration of eight seconds. A trained helper timed the exercise and made sure that the exercise was properly executed. An illustration of the exercise follows in Figure 8.

FIGURE 8

EXECUTION OF THE ISOMETRIC EXERCISE FOR WRIST PALMAR FLEXION

In the combined palmar flexion-arm extension exercise, the subject utilized the same exercise apparatus but with the arm positioned so that an angle of ninety degrees was formed between the upper arm and the forearm. In this exercise the handle was placed across the palm of the hand instead of the fingers. The subject then exerted maximum force against the handle for a duration of eight seconds. An assistant called out the time and checked for proper execution. Figure 9 illustrates the execution of this exercise.

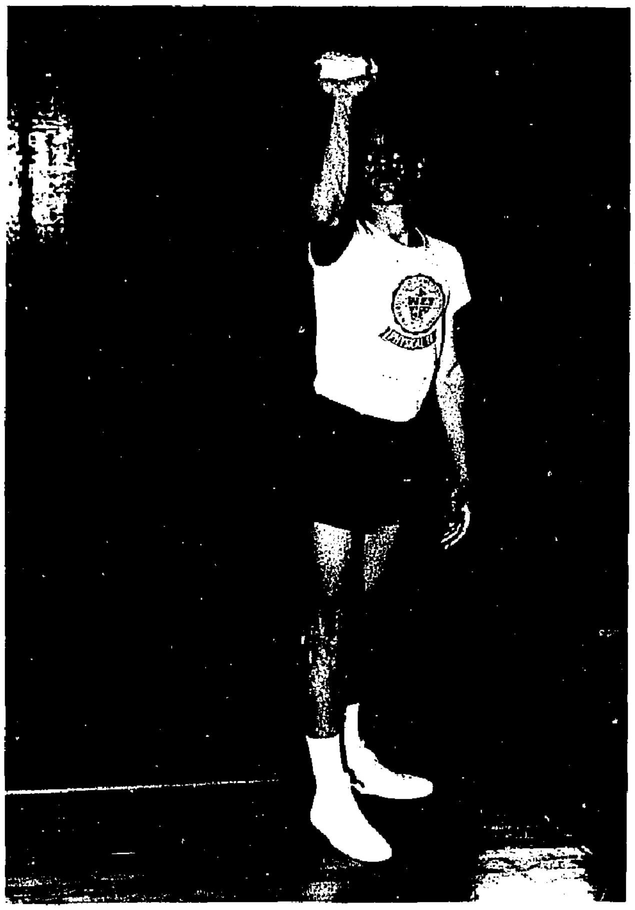

FIGURE 9

EXECUTION OF THE ISOMETRIC EXERCISE FOR COMBINED PALMAR FLEXION-ARM EXTENSION STRENGTH

In the arm push exercise, the subject pushed a basketball against a regular balanced scale which was mounted on an adjustable platform, as shown in Figure 6, page 33. Thus the exercise was done under the same conditions as in the testing since it involved very little time to make the height adjustments. The amount of force exerted against the scale with the ball was read by a student assistant and recorded on the subject's data sheet. This exercise was primarily used for motivating purposes.

Group A began shooting with the regulation ball at the goal previously assigned them. Each subject attempted five shots from each of the six stations around an arc twenty-five feet from the base line, but subjects were allowed no trials directly in front of the basket as performed in the testing. Scores were recorded daily for incentive purposes. Assistants retrieved the ball for the subjects.

Group C began practicing the two-hand chest pass utilizing the heavy ball. Four practice targets were available for this practice. The subject passed the ball at the target thirty times from a distance of twenty-five feet. An assistant was present at each target to retrieve the ball for the subject. The subjects were reminded to strive for both speed and accuracy.

After Group D completed the isometric exercises, the subjects in that group used the heavy balls to pass at the wall targets. Speed and accuracy were stressed in all passes.

After completing the isometric exercise, Group B began shooting thirty shots with the regulation basketballs. Five attempts were made from each of the six shooting stations around the basket, making thirty shots each practice session.

Group C began shooting with the heavy balls on the practice goal assigned to them. The same shooting procedures were followed.

After Group D finished passing for speed and accuracy at the practice targets, they used the heavy basketball for practicing thirty shots at the goal. The same shooting procedures described earlier were used.

After Group A completed the thirty shots at the assigned goal they began passing at the practice targets, following the same practice procedure as done by all groups.

After Group B completed the thirty practice attempts, the subjects of the group began passing for speed and accuracy at the practice targets.

It should be pointed out that the training procedures for this study demanded precise organization and full cooperation of the subjects. The writer made every attempt to keep all subjects busy every minute of the class period and each group engaged in a different aspect of the training program at all times.

VIII. STATISTICAL ANALYSIS

The following statistical computations were made in analyzing the data:

1. The mean gains were computed for each of the variables tested for each of the four groups. The t-test for correlated groups as presented in Garrett's book[3] was used.

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[3]Henry E. Garrett, Statistics in Psychology and Education (Fifth edition; New York: Longmans, Green and Company, 1958), pp. 227-28.

2. In cases where significant gains were found, analysis of covariance utilizing orthogonal comparisons was employed to determine the cause of the differences.
3. The coefficients of correlation were computed using the product-moment method to determine the relationship among the variables in the study.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

I. COMPARISON OF THE EFFECTS OF FOUR TRAINING PROGRAMS ON SHOOTING ACCURACY

In establishing the significance of the mean gains in shooting accuracy scores for the four groups utilizing different training programs, t-tests were computed. Group A utilized a regulation basketball in the program, Group B used the regulation ball and supplementary isometric exercises, Group C used a basketball which weighed almost twice as much as the regulation ball, and Group D used the heavy ball and isometric exercises. The results of these comparisons are presented in Table I.

TABLE I

ANALYSIS OF THE MEAN GAINS BETWEEN INITIAL AND FINAL SCORES FOR SHOOTING ACCURACY FOR THE FOUR TRAINING PROGRAMS

Groups	N	Initial Mean	Final Mean	Mean Diff.	SE Diff.	t	p
A	25	18.1	23.0	4.9	1.48	3.32	.01
B	25	15.5	21.1	5.6	1.34	4.22	.01
C	25	18.5	20.9	2.4	1.71	1.41	N.S.
D	25	17.5	18.9	1.4	1.05	1.31	N.S.

t needed at .05 level, 2.07; t needed at .01 level, 2.81
A: Group using the regulation basketball only
B: Group using the regulation basketball and isometric exercises
C: Group using the heavy basketball only
D: Group using the heavy ball and isometric exercises

The t-ratios needed for significance were 2.07 at the .05 level of probability and 2.81 at the .01 level. The t-ratio resulting from the comparison of the initial and final shooting accuracy scores for Group A (regulation ball only) was 3.32 and 4.22 for Group B (regulation ball plus isometrics). Both t-ratios were significant at the .01 level of confidence. This indicated that both training programs which utilized a regulation ball were effective in producing significant improvement in shooting accuracy.

The computed t-ratios for Group C (heavy ball) and Group D (heavy ball plus isometrics) were 1.41 and 1.31, respectively, which were below that needed for significance at the .05 level of probability. This indicated that training programs consisting of the use of a heavy ball and/or the heavy ball with supplementary isometric exercises were not effective in improving shooting accuracy when the accuracy was measured by shooting a ball of regulation weight.

<u>Comparison of the Four Training Programs in the Development of Shooting Accuracy by Covariance</u>

In order to provide greater insight into the comparative effects of the four training programs on shooting accuracy, analysis of covariance employing orthogonal comparisons was used to determine if significant differences among the four experimental groups in shooting accuracy occurred, and, if so, what treatment, or combination of treatments, were responsible for the differences.

The results of the analysis of covariance computed for the comparative effects of the regulation and heavy ball, the isometric exercises and the interaction between the ball and isometric exercises are shown in Table II. To reach significance, an F-ratio of 3.94 was required for the .05 level of probability and an F-ratio of 6.90 was needed for the .01 level. In Table I, page 41, it was shown that both groups practicing with the regulation ball, Groups A and B, made significant gains in shooting accuracy. As shown in Table II, after the sum of squares was adjusted for any initial differences, the effects of the ball, the isometric exercises, and the interaction between the ball and the isometric exercises, it was found that there were actual differences among the group in final shooting accuracy. The differences were caused by the effect of practice with the regulation ball rather than by the effects of isometric exercises.

TABLE II

ANALYSIS OF COVARIANCE FOR THE FOUR GROUPS OF COLLEGE MEN ON SHOOTING ACCURACY PERFORMANCE

Source of Variation	Adjusted Sum of Squares	df	Mean Square	F	P
Ball	172	1	172	4.61	.05
Isometric Exercises	13	1	13	.34	N.S.
Interaction B x I	6	1	6	.19	N.S.
Error	3541	95	37.27		
Total	3732	98			

F needed at .05 level, 3.94; F needed at .01 level, 6.90
Adjusted means of the groups:
Group A (Regulation Ball) 22.3; Group B (Regulation Ball and Isometrics) 21.9; Group C (Heavy Ball) 20.0; Group D (Heavy Ball and Isometrics) 18.8

This is established by the significant F-ratio of 4.61 found in the covariance analysis for the effects of the ball used in training. This F was significant at the .05 level of probability. Therefore, by examining the adjusted final means of the four groups shown in Table II, page 43, it is evident that the two groups training with the regulation ball improved more in shooting performance than the groups who practiced with the heavy ball. The fact that no significant F was obtained in the analysis for the effect of isometric exercises, nor was any significant interaction effect found, indicated that practice with the regulation basketball, with or without isometric exercises, was the determining factor in improving shooting accuracy.

II. ANALYSIS OF THE MEAN GAINS OF THE FOUR EXPERIMENTAL GROUPS IN THE COMBINED SCORES OF VELOCITY AND ACCURACY OF THE TWO-HAND CHEST PASS WHEN SPEED AND ACCURACY WERE STRESSED

The original scores of passing velocity measured in feet per second and passing accuracy measured in centimeters were computed and converted into T-scores in order to combine the two scores for statistical analysis.

In Table III, it can be seen that none of the four training programs resulted in significant improvement in the combined passing velocity and accuracy scores from initial to final testing. The t-ratios of -.09 for Group A, -.31 for Group B, -.08 for Group C, and .41 for Group D were all well below the ratio of 2.07 needed to be significant at the .05 level of probability. Because none of the four groups showed significant improvement in combined passing velocity and accuracy, it was considered pointless to compare the four groups by covariance, as was done with shooting accuracy.

TABLE III

ANALYSIS OF MEAN GAINS BETWEEN INITIAL AND FINAL T-SCORES FOR COMBINED PASSING VELOCITY AND PASSING ACCURACY FOR THE FOUR TRAINING PROGRAMS

Groups	N	Initial Mean	Final Mean	Mean Diff.	S.E. Diff.	t	P
A	25	100.04	99.79	-.25	2.75	-.09	N.S.
B	25	100.75	99.75	-1.00	3.28	-.31	N.S.
C	25	100.25	99.96	-.29	3.72	-.08	N.S.
D	25	99.71	101.00	1.29	3.16	.41	N.S.

t needed at .05 level, 2.07; t needed at .01 level, 2.81
Group A (Regulation Ball)
Group B (Regulation Ball and Isometric Exercises)
Group C (Heavy Ball)
Group D (Heavy Ball and Isometric Exercises)

In order to obtain as much information as possible concerning the effects of the different programs on passing performance, the two variables of accuracy and velocity were analyzed separately.

<u>Analysis of the Mean Gains of Each of the Four Experimental Groups in Passing Accuracy When Speed and Accuracy Were Stressed</u>

The difference between the initial and final mean in passing accuracy for each group was computed by the t-test for correlated groups and the data are presented in Table IV. The t-ratios needed for significance were 2.07 at the .05 level of probability and 2.81 at the .01 level of probability. The computed t-ratios of -1.64 for Group A, -.84 for Group B, -1.98 for Group C, and -1.18 for Group D all failed to reach significance at the .05 level of probability.

TABLE IV

ANALYSIS OF MEAN GAINS BETWEEN INITIAL AND FINAL SCORES OF PASSING ACCURACY FOR THE FOUR TRAINING PROGRAMS

Groups	N	Initial Mean	Final Mean	Mean Diff.	S.E. Diff.	t	P
A	25	25.05	21.59	-3.46	2.11	-1.64	N.S.
B	25	23.12	21.73	-1.39	1.66	-.84	N.S.
C	25	22.37	19.14	-3.23	1.63	-1.98	N.S.
D	25	24.23	21.80	-2.43	2.05	-1.18	N.S.

t needed at .05 level, 2.07; t needed at .01 level, 2.81
A: Group using regulation basketball only
B: Group using regulation ball and isometric exercises
C: Group using the heavy basketball only
D: Group using the heavy ball and isometric exercises

Consequently, none of the four training programs produced significant improvement in passing accuracy when both speed and accuracy were stressed.

Analysis of the Mean Gains of Each of the Four Experimental Groups in Passing Velocity When Speed and Accuracy Were Stressed

The results of the analysis of the mean gains in passing velocity are shown in Table V. The computed t-ratios were 4.92 for

Group B (regulation ball and isometric exercises) and 4.88 for Group C (heavy ball only). Both of the ratios are significant beyond the .01 level of probability. This indicates that the training programs utilizing the regulation ball with supplementary isometric exercises and training with the heavy ball alone were effective in improving passing velocity when speed and accuracy were emphasized.

TABLE V

ANALYSIS OF MEAN GAINS BETWEEN INITIAL AND FINAL SCORES OF PASSING VELOCITY FOR THE FOUR TRAINING PROGRAMS

Group	N	Initial Mean Feet per Second	Final Mean Feet per Second	Mean Diff.	S.E. Diff.	t	P
A	25	29.99	30.67	.68	.63	1.07	N.S.
B	25	29.51	31.45	1.94	.39	4.92	.01
C	25	28.46	32.60	4.14	.85	4.88	.01
D	25	28.16	29.32	1.16	.80	1.45	N.S.

t needed at .05 level, 2.07; t needed at .01 level, 2.81
A: Group using regulation basketball only
B: Group using regulation ball and isometric exercises
C: Group using the heavy basketball only
D: Group using the heavy ball and isometric exercises

The t-ratios of 1.07 for Group A and 1.45 for Group D were not significant. This indicated that the training program involving the regulation basketball alone and practicing with the heavy ball along with isometric exercises were not effective in improving the velocity of the basketball chest pass when both speed and accuracy were stressed.

Comparison of the Four Training Programs in the Development of Velocity in the Two-Hand Chest Pass by Analysis of Covariance

Since the analysis of mean gains revealed that two of the groups had made significant improvement in passing velocity (Table V, page 47), covariance was utilized to determine whether there were any actual differences among the four training programs. The results of the analysis of covariance for the separate effects of the ball, the isometric exercises, and the interaction of ball and exercises are presented in Table VI.

TABLE VI

ANALYSIS OF COVARIANCE FOR THE FOUR GROUPS OF COLLEGE MEN IN PASSING VELOCITY

Source of Variation	Adjusted Sum of Squares	df	Mean Square	F	P
Ball	12.77	1	12.77	1.26	N.S.
Isometric Exercises	28.47	1	28.47	2.81	N.S.
Interaction B x I	103.86	1	103.86	10.27	.01
Error	960.64	95	10.11		
Total	1105.74	98			

F needed at .05 level, 3.94; F needed at .01 level, 6.90
Adjusted Means of Groups:
Group A (Regulation Ball) 30.3; Group B (Regulation Ball and Isometric Exercises) 31.2; Group C (Heavy Ball) 32.9; Group D (Heavy Ball and Isometric Exercises) 29.9

As could be expected from the analysis of mean gains, there was no significant F ratio found for either the effects of the ball used in training, or for the effects of the isometric exercises when compared separately. However, a significant interaction effect was demonstrated by the F ratio of 10.27 for this comparison which was significant beyond the .01 level of probability. In part, this, too, was to be expected from the results of the mean gains analysis for each group.

Interpreted literally, the interaction for the variables in this study was a comparison of the effects of isometric exercises subtracted from the absence of isometric exercises in training with the regulation ball, as opposed to the effects of isometric exercises subtracted from the effects of the absence of isometric exercises in training with the heavy ball. Thus, if the effects of isometric exercises were the same under conditions of practice with the regulation ball as with practice with the heavy ball, then there would be no interaction effect.

Perhaps it may be stated more simply by saying that the significant interaction for this analysis means that the effects of isometric exercises, used in conjunction with practice with the regulation ball, were not the same as when used in training with the heavy ball, insofar as passing velocity was concerned. The final adjusted means for the four groups shown in Table VI were 30.3 for Group A (regulation ball only), 31.2 for Group B (regulation ball plus isometrics), 32.9 for Group C (heavy ball only), and 29.9 for Group D (heavy ball plus isometrics). In order to study the nature of this interaction between the regulation ball and the heavy ball with and without isometric exercises, the difference between the differences in means was computed. The difference between the means of Group B, regulation ball and isometrics, and Group D, heavy ball and isometrics, was 1.3 in favor of Group B. The difference between the means of Groups A and C, regulation ball and heavy ball groups without isometric exercises, was -2.6 in favor of Group C. The difference between these two differences which resulted in the significant F for the interaction was 3.9. This indicates that practice with the regulation ball with supplementary isometric exercises are a better combination than practice with the heavy ball with isometric exercises in developing passing velocity; and, that training with the heavy ball alone is more beneficial in improving passing velocity than is training with the regulation ball alone.

A coefficient of correlation was computed between passing accuracy and passing velocity scores of the subjects in the study. The resulting correlation coefficient was -.28. With 98 degrees of freedom (N-2), an r of .197 is needed for significance at the .05 level, and .257 at the .01 level of confidence. Therefore, this relationship was significant at the .01 level.

However, it should be pointed out that the negative correlation in this case was actually a positive relationship because of the nature of the accuracy scores. In this test, the score was the deviation in centimeters from the center of the target, thus the less accurate, the higher the score. Consequently, this relationship means that those who threw the ball with more velocity were the more accurate. This finding is in agreement with Fulton's study,[1] cited earlier. Davis and others[2] also concluded that when accuracy and velocity are simultaneously stressed in a movement, the greater accuracy is obtained by performing the movement at optimum speed.

Analysis of Strength Measures

The analysis of strength gains and the relationship of the strength measures with performance was not a specified purpose of the study. The primary reason for measuring strength was for motivation purposes of the subjects engaging in isometric exercises. However, it was also considered important to determine whether the strength exercises actually brought about significant gains in strength, as performed and measured in this study. For the latter reason, it was deemed appropriate to present the data for the three strength measures for each of the four groups of subjects.

Palmar Flexion Strength

In Table VII, the initial and final means and the significance of the difference between the two tests for palmar flexion strength scores are presented. The resulting t-ratios reveal that significant gains were experienced by only two groups, both of which used the heavy ball in training.

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[1]Fulton, *loc. cit.*

[2]E. C. Davis, G. A. Logan and W. C. McKenney, *Biographical Values of Muscular Activity.* (Dubuque; Wm. C. Brown Company, Inc., 1965), p. 38.

Group C (heavy ball only) had a t-ratio of 2.94 which was significant at the .01 level of confidence. Group D (heavy ball plus isometrics) had a t-ratio of 2.37 which reached significance at the .05 level. The regulation ball training groups (Groups A and B) did not gain significantly in palmar flexion strength. These results correspond in an inverse manner with the previous analysis of shooting accuracy where it was found that only the regulation ball groups improved significantly in shooting.

TABLE VII

ANALYSIS OF MEAN GAINS BETWEEN INITIAL AND FINAL SCORES OF WRIST PALMAR FLEXION STRENGTH

Groups	N	Initial Mean	Final Mean	Mean Diff.	S.E. Diff.	t	P
A	25	43.96	45.43	1.47	1.24	1.18	N.S.
B	25	44.81	44.89	.88	.95	.08	N.S.
C	25	47.18	50.94	3.76	1.28	2.94	.01
D	25	46.57	50.49	3.92	1.65	2.37	.05

t needed at .05 level, 2.07; t needed at .01 level, 2.81
A: Group using the regulation basketball only
B: Group using the regulation basketball and isometric exercises
C: Group using the heavy ball only
D: Group using the heavy ball and isometric exercises

Further analysis by correlation of palmar flexion strength with shooting accuracy resulted in an r of .06 which was not significant. These findings may be interpreted as follows: (1) The use of the heavy ball in training produced strength in palmar flexion whereas practice with the regulation ball did not, even when a specific isometric exercise for palmar flexion was supplemented; (2) increased strength in palmar flexion was not a factor in accuracy in shooting. In fact, no relationship was found to exist between shooting accuracy and palmar flexion strength when the accuracy was measured by shooting a regulation ball at a basket from the distance employed in this study.

To complete the analysis of palmar flexion strength, covariance was utilized to compare the effects of the ball used, the effects of the isometric exercises, and the interaction effects. In Table VIII, it can be seen that the only significant F-ratio was for the effects of the ball used in training by the groups. By examining the adjusted final means, it is shown that the two groups (Group C and D) who practiced with the heavy ball had higher means than the regulation ball groups (Groups A and B). Since the analysis for the effects of the isometric exercises did not result in a significant F-ratio, it is evident that the increase in palmar flexion strength was produced by the ball, rather than the supplementary isometric exercises, or an interaction between the variables.

<u>Combined Palmar Flexion-Arm Extension Strength</u>

The analysis of the mean gains between the initial and final scores in combined palmar flexion-arm extension strength are found in Table IX, page 55. None of the four experimental groups made significant improvement. Therefore, as measured palmar flexion-arm extension strength was not increased by specific isometric exercises nor by shooting or passing a regulation basketball or a weighted basketball.

TABLE VIII

ANALYSIS OF COVARIANCE FOR THE FOUR GROUPS OF COLLEGE MEN IN WRIST PALMAR FLEXION STRENGTH

Source	SS	df	MS	F	P
Ball	245.73	1	245.73	6.42	.05
Isometric Exercise	12.96	1	12.96	.34	N.S.
Interaction B x I	20.70	1	20.70	.54	N.S.
Error	3636.60	95	38.28		
Total					

F needed at .05 level, 3.95; F needed at .01 level, 6.92
A: Group using the regulation ball only, 47.36
B: Group using the regulation basketball and isometric exercises, 45.72
C: Group using the heavy ball only, 49.59
D: Group using the heavy ball and isometric exercises, 49.81

Palmar flexion-arm extension strength was found to have a coefficient of correlation of -.08, actually no relationship, with passing accuracy. However, palmar flexion-arm extension strength was correlated with passing velocity as evidenced by an r of .29 which, although not a very high relationship, was definitely significant at the .01 level of confidence. As would be expected from earlier analysis, this variable had a very low correlation (.10) with shooting accuracy. Since no significant gains were made by any of the four groups, no further analysis was appropriate.

Two-Hand Push Exercise

The two-hand push exercise was also primarily included as a means of motivation. The exercise was performed in the same position as that employed for the two-hand chest pass. A t-ratio of 2.07 was needed to be significant at the .05 level of probability and a t-ratio of 2.81 was needed at the .01 level. In Table X, it is seen that the difference between initial and final means resulted in a t of .16 for Group A, 1.41 for Group C, and a t-ratio of 1.70 for Group D. The gains of these three groups all failed to reach

TABLE IX

ANALYSIS OF MEAN GAINS BETWEEN INITIAL AND FINAL COMBINED PALMAR FLEXION-ARM EXTENSION STRENGTH SCORES

Group	N	Initial Mean	Final Mean	Mean Diff.	S.E. Diff.	t	P
A	25	58.49	59.17	.68	1.43	.48	N.S.
B	25	56.06	57.90	1.84	1.62	1.13	N.S.
C	25	59.84	61.41	1.57	1.32	1.18	N.S.
D	25	57.04	59.28	2.24	1.69	1.32	N.S.

t needed at .05 level, 2.07; t needed at .01 level, 2.81
A: Group using the regulation basketball only
B: Group using the regulation ball and isometric exercises
C: Group using the heavy ball only
D: Group using the heavy ball and isometric exercises

significance. Group B was the only group which improved significantly in the two-hand push exercise. The t-ratio of 2.49 was significant at the .05 level of probability. The results indicated that only the group which trained with the regulation ball and supplementary exercises significantly improved strength in this exercise.

TABLE X

ANALYSIS OF MEAN GAINS BETWEEN INITIAL AND FINAL TWO-HAND PUSH EXERCISE SCORES

Groups	N	Initial Mean	Final Mean	Mean Diff.	S.E. Diff.	t	P
A	25	47.58	47.42	-.16	1.04	.16	N.S.
B	25	49.38	51.71	2.33	.94	2.49	.05
C	25	45.42	47.42	2.00	1.42	1.41	N.S.
D	25	49.21	51.46	2.25	1.33	1.70	N.S.

t needed at .05 level, 2.07; t needed at .01 level, 2.81
A: Group using the regulation basketball only
B: Group using the regulation ball and isometric exercises
C: Group using the heavy ball only
D: Group using the heavy ball and isometric exercises

Strength measured by this exercise showed very little relationship with either of the passing scores. The two-hand push exercise had a coefficient of correlation of -.06 with passing accuracy and .16 with passing velocity, both of which were not significant. Therefore, the gain in strength experienced by the group utilizing isometric exercises with the regulation basketball practice (Group B) had no bearing on passing performance, even though this group did show a significant gain (see Table V, page 47) in passing velocity. On the other hand, Group C (heavy ball only) also showed a significant gain in passing velocity, but showed no real gain in the strength measured by this exercise. Thus, both findings bear out the lack of relationship of passing velocity with the two-hand push strength exercise.

Since a significant gain in this exercise was noted by one group, covariance was again employed to see whether this group showed any real superiority over the other groups. Table XI reveals that no significant differences existed among the four groups in the two-hand push exercise. The F-ratio for the ball effects (.72), the exercise effects (1.95), and interaction (.58) all failed to reach significance at the .05 level of probability.

TABLE XI

ANALYSIS OF COVARIANCE FOR THE FOUR GROUPS OF COLLEGE MEN IN THE TWO-HAND PUSH EXERCISE SCORES

Source	Sum of Squares	df	Mean Square	F	P
Ball	22.87	1	22.87	.72	N.S.
Isometric Exercises	51.85	1	62.33	1.95	N.S.
Interaction B x I	18.75	1	18.75	.58	N.S.
Error	3030.34	95	31.89		
Total	3123.81	98			

F needed at .05 level, 1 and 95 df = 3.95
F needed at .01 level, 1 and 95 df = 6.92
Group A (Regulation Ball) 49.34
Group B (Regulation Ball and Isometric Exercises) 50.23
Group C (Heavy Ball) 49.6
Group D (Heavy Ball and Isometric Exercises) 50.36

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

I. SUMMARY

The primary purpose of this study was to determine the effects of four training programs on the development of velocity and accuracy in motor performance when accuracy alone was stressed and when speed and accuracy are stressed.

A second purpose of the study was to determine the relationship between performance and strength of the muscle groups involved in shooting for accuracy and passing for speed and accuracy.

The subjects involved in this study were one hundred freshman male students enrolled in required physical education classes at the University of Southwestern Louisiana, Lafayette, Louisiana.

One week prior to the beginning of the study, all subjects were given written and verbal instructions, demonstrations and practice in the techniques involved in the one-hand push shot for accuracy and the two-hand chest pass for velocity and accuracy.

During the week following the orientation sessions, all subjects were tested twice for wrist palmar flexion strength and combined palmar flexion-arm extension strength by means of a cable tensiometer. Initial tests of thirty trials were also administered in shooting accuracy. The next week was utilized to administer the initial tests of thirty trials in passing velocity and accuracy as well as the test for strength in the two-hand push exercise which was similar to the position assumed for the two-hand chest pass. The regulation Voit basketball was used in the shooting and passing tests.

The subjects were randomly divided into four experimental groups of twenty-five subjects each. Each group performed the same tasks of thirty shots for accuracy and thirty passes at a target striving for both speed and accuracy. All four groups practiced three times per week for five weeks.

Group A utilized a regulation Voit basketball during the training program. Group B used the regulation ball and three supplementary isometric exercises designed to strengthen the muscle groups involved in the shooting and passing performance. Group C used a weighted Voit basketball weighing almost twice as much as the regulation basketball, and Group D trained with the heavy basketball and also were given the same three supplementary isometric exercises as Group B during the training program.

At the end of the five-week training period, the strength tests and the tests in shooting accuracy and passing velocity and accuracy were again administered.

The data were analyzed by means of the t-test for correlated means to establish the significance of the mean gains for each of the groups in each of the variables investigated where significant t-ratios were found, analysis of covariance, utilizing orthogonal comparisons, was used to determine whether significant differences existed among the groups and the effects of the type ball used in training, the effects of the isometric exercises, and the interaction between the type of ball and the exercises. In addition, coefficients of correlation were computed to determine the relationships among the variables studied.

II. FINDINGS

The findings of this study were as follows:

1. In the motor skill involving basketball shooting in which accuracy alone was stressed, the subjects in the two groups practicing with the regulation ball improved significantly whereas the subjects who trained with the heavy ball did not. Through orthogonal comparisons, it was found that the significant difference was due to the effect of the ball used in the training and not the effects of isometric exercises, nor any interaction effect of ball and exercise.
2. In the motor skill in which accuracy and velocity were both stressed, no significant improvement was made by any of the four groups on their combined accuracy and velocity scores for the two-hand chest pass.
3. When passing velocity scores were analyzed separately, it was found that the group practicing with the regulation basketball along with supplementary isometric exercises, and the group using only the heavy basketball in training

showed significant improvement. The group using the regulation ball only and the group using the heavy ball along with isometric exercises did not improve their passing velocity scores. No significant gains were made by any of the groups in passing accuracy.

4. Wrist palmar flexion strength nor arm extension strength, as measured in this study, were significantly related to shooting accuracy.
5. A significant coefficient of correlation was found between passing accuracy and passing velocity.
6. Significant gains in palmar flexion strength were realized by the subjects in the two groups which utilized the heavy ball while training. The subjects using the regulation ball, even those practicing isometric exercises, did not show any significant strength gains in palmar flexion.
7. Combined palmar flexion-arm extension strength was found to have a low, but significant, relationship with passing velocity. However, arm extension strength was not significantly improved by specific isometric exercises, by practicing with a weighted ball, or by practicing with a regulation ball.
8. In the strength measured by the two-hand push exercise, only one group, the group using the regulation ball along with isometric exercises, gained significantly at the .05 level of confidence. Strength measured in this exercise was not related to passing accuracy or passing velocity.

Discussion of Findings

It was found that for the subjects who participated in this study, improvement in the one-hand push shot in basketball was improved by those subjects who practiced with the same type of ball that was used in the testing. This agreed with most authorities on learning in that the most effective practice should be conducted in the same situation in which the desired performance is to be given. It seemed reasonable to assume that if the subjects had been tested for shooting accuracy with the heavy ball that those subjects who had trained with that ball would have performed better than the regulation ball groups.

Several questions were introduced as a result of this finding, however. One question was why some basketball coaches utilize a heavy ball in early season practice? Perhaps the level of skill that a player possesses is a factor. In this study, the subjects were not highly skilled basketball players, although some had been on varsity teams in high school. The subjects using the heavy ball in practice did significantly gain in strength of palmar flexion which is greatly involved in the execution of the one-hand push shot. Therefore, use of a heavier ball produced strength of these muscles. Yet, it was found that there was no relationship between strength and shooting accuracy insofar as this distance from the basket was concerned. It could well be that as the distance from the basket increases strength might become increasingly important.

The problem was further complicated, however, by the fact that an increased distance of just a few feet made practice with the heavy ball almost prohibitive by most of the subjects in this study. This was observed by the investigator when it had originally been planned to utilize a distance of thirty feet for this task. The distance was consequently reduced to the present distance because of the inability of the subjects to perform the shot with any semblance of the prescribed form. Therefore, the question of the usefulness of a heavy ball for shooting still remains.

Possibly more light would have been shed on the efficacy of using a heavy ball in practice if the subjects training with this ball had been given periodic practice with the regulation ball. The adjustment required when shifting back to the regulation ball may have been a big factor. Perhaps even more important may have been the lack of reinforcement while training for the heavy ball groups. It has been well established that learning and performance are greatly facilitated when the subject experiences success to the degree that he is stimulated to improve rather than to become frustrated from repeated failures.

Nevertheless, the fact remained that there was a definite absence of relationship between strength and accuracy both in shooting and in passing performance. Evidently, such factors as eye-hand coordination, kinesthetic sensitivity, and judgment in terms of height, distance and direction are of much greater importance for accuracy in motor skills. Needless to say, general body strength may be a significant underlying factor for most, or all motor skills, and that specific strength may play an increasingly important role as distance from a target is increased. In addition, strength is undoubtedly involved when the length of time and/or intensity of repeated execution of the motor skill, in this case accuracy, is of such duration that performance is adversely affected due to lack of stamina.

The results of the passing performance for the four groups in this study were difficult to analyze. It was found that when the scores of passing accuracy and the scores of passing velocity were combined, none of the groups showed any significant improvement as a result of practice. When passing accuracy and velocity were considered separately, it was found that velocity was increased by two of the groups, whereas accuracy was not improved by any group. In addition, a significant correlation was obtained between passing accuracy and velocity which meant that those who threw with greater velocity were generally more accurate in passing than those who threw with less velocity.

Part of the explanation for these findings may have been due to the subjects being more inclined to strive for velocity rather than accuracy. As was stated earlier, the investigator stressed that they should concentrate on both variables equally and the investigator constantly reminded the subjects of the importance of this. Neverthe-less, the author noted that, generally, the subjects seemed to be most intent on throwing as hard as they could. This inclination may be typical of males, especially. It was observed by Smith and Harrison[1] that the speed set tends to predominate the accuracy set which results in neuromotor disorganization and subsequent loss of accuracy.

Therefore, this may have, to some extent, accounted for gains in velocity but not in accuracy. Furthermore, when the scores of the two variables were combined into one score, the lack of improvement in accuracy undoubtedly nullified the improvements in velocity.

It was much more difficult for the investigator to attempt to explain the combination of training methods which were found to significantly increase passing velocity. A significant interaction was obtained which showed that the group practicing with the regulation ball along with supplementary isometric exercises, and the group who used only the heavy ball in training experienced significant velocity gains. If the subjects who practiced with the heavy ball along with isometric exercises had also improved, it could be attributed to resistance exercises, but this was not the case. Therefore, possibly it could be attributed to errors of chance which are inherent in all statistical tests of significance; or, conceivably, there may have been a counterbalancing effect of using isometric exercises along with the heavy ball, perhaps due to fatigue. The writer was not able to find any evidence in the literature which would support the latter

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[1]Smith and Harrison, loc. cit.

statement concerning any prolonged fatigue effects from isometric exercises.

The problem is compounded by the lack of significant gains found for the various strength measures. Isometric exercises failed to produce gains in nearly all of the exercises employed in the study. As this was contrary to the vast majority of studies done concerning isometric exercises, the author suggested one of two possible explanations. One reason might have been that the muscle groups investigated were of such a nature that it was very difficult to show a change of any magnitude, at least within the time period of this study. A second possibility may have been that the subjects simply did not exert themselves to the extent needed for a significant increase of these muscle groups. However, every effort was made by the investigator to urge the subjects to exert maximum effort. Periodic measurements were made to provide knowledge of scores; the author verbally exhorted the subjects to push harder while they were exercising; and they had been told that a rough self-evaluation of their exertion was that if their faces were not red and they were not breathing hard at the end of the exercise, they were not working hard enough. Therefore, from personal observation during the training program, it was believed by the investigator that the first explanation concerning the nature of the muscle groups involved, was most credible as a reason for not obtaining significant strength gains.

III. CONCLUSIONS

Within the limitations of this investigation, the following conclusions appeared to be justified:

1. Individual differences in strength of the muscle groups involved are not a significant factor in accuracy in a motor skill when the skill is performed within normal distances and when using an object whose weight is commensurate with the capabilities of the average performer for whom the skill is intended.
2. Shooting accuracy in the one-hand push shot in basketball is best improved when the subjects practice with the regulation basketball. The use of a weighted basketball and/or the use of supplementary exercises does not result in basketball shooting improvement.
3. Accuracy in a motor skill such as the two-hand chest pass is difficult to improve when velocity and accuracy are simultaneously stressed. There is a tendency for the velocity set to dominate the accuracy set.
4. A rather low, but significant, positive relationship exists between velocity and accuracy in a motor skill when both velocity and accuracy are stressed.
5. Passing velocity can be increased through practice with a basketball weighing approximately twice as much as a regulation ball, and through practice using a regulation

ball along with supplementary isometric exercises for the muscle groups involved.

IV. RECOMMENDATIONS

As a result of this study, the following recommendations for further study were suggested:

1. A study similar in design to this investigation, but which would permit the heavy ball groups to have periodic practice with the regulation ball.
2. A study which would investigate the effects of strength in accuracy at different distances and with different motor skills such as archery, baseball throwing, and golf.
3. An experiment which would stress passing accuracy alone, and passing velocity alone to compare with the performance obtained when both accuracy and velocity are stressed.
4. A study to determine the effects of the use of a weighted ball on shooting and passing performance using highly skilled subjects.

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APPENDIXES

APPENDIX A

DETAILED INSTRUCTIONS GIVEN TO SUBJECTS RELATING TO MECHANICS AND TECHNIQUES IN SHOOTING THE ONE-HAND PUSH SHOT[1]

Placement of feet. This particular phase of shooting was left to the discretion of each individual subject. They were informed that coaches differ in placement of the feet with some preferring a stance with the toes pointed straight at the basket while others prefer to have the toes pointing at a forty-five degree angle. However, it is more generally recommended that right handers place the right foot slightly ahead of the left in executing the shooting action. The subjects were instructed to practice a few shots from both foot positions and encouraged to determine which foot position was better for them. It was suggested that his selected foot position be used throughout the study.

The feet should be spread comfortably to insure good balance, with the weight of the body equally distributed on the balls of the feet. The basket should be faced squarely, with the knees slightly bent.

Holding the ball. The ball should be cradled with the left hand. This position is directly under the ball, with the fingers spread.

[1]Gilman Hertz, "The Effectiveness of Three Methods of Instruction in One-Hand Foul Shooting." (microcarded Doctoral dissertation, Indiana University, Bloomington, 1956).

The right hand is placed on top of the ball directly in the center. The fingers are spread as far as possible to insure better control of the shot and located along the seams of the ball. It was advocated that considerable pressure be exerted by the tips of the fingers, especially the little finger and thumb. Doing this has a tendency to remind the shooter that at no time should the palm of the hand come in contact with the ball and to minimize lateral deviation in the flight of the ball. The elbows should be held fairly close to the body and the arms should not be extended forward to an unnatural position. The ball position is of great importance. The ball should be brought up to a point in front of the right shoulder and slightly inward toward the center of the body. When sighting for the basket, the ball should be held about eye level.

Execution of the shot. From this position, the knees dip slightly and are extended with the shot. Simultaneously with the leg action, there is an unlocking of the wrists to obtain better relaxation and rhythm. Both hands should be on the ball, with the elbows close to the body. The angle between the upper and lower arm remains ~~the~~ same throughout this motion. An exaggerated pumping motion of the ball and arms would tend to destroy the rhythm. From the floor, this extra motion might well result in the shot being blocked.

As the shot is initiated, the motion of the arm should be an upward, vertical movement, not a lateral one. As the right hand pushes the ball toward the basket, the left hand guides for a short distance and then drops from the ball as the right arm continues its push toward the basket. The ball is released from the fingers and is assisted by the hinge-like action of the wrist combined with an extended action of the arm. The ball literally rolls off the fingers, which consequently applies a natural back-spin to the ball. This spin helps maintain the direction of the ball by preventing drifting and retards the ball's rebound from the board, thereby compensating for too much speed on the ball in shooting. A soft shot will have a better chance of dropping through, even though the flight of the ball is not absolutely accurate. Contrary to most advice, the eyes are not kept on the ball in this instance, but on the point of aim, the center of the basket. Follow through of the arm is the final essential for proper execution of the shot. The arm should end up extended in the same plane as the angle of projection with the wrist depressed as if waving good-bye to the ball. Follow through can be emphasized by audibly repeating the words "Follow through" as the ball is released, until the pattern is set. The follow through may include a rise to the toe of the right foot with the left coming off the floor.

General advice:

1. Control the ball with the fingertips, shoot medium balls, and follow through with the arms and body after each shot attempt.
2. Keep the body relaxed when shooting. Relaxation can be attained by flexing the knees and trunk slightly, and by

keeping the shoulders and arms loose.

3. Good shooters are not born; they develop through constant practice.
4. Shooting must be a habit. To acquire this habit, one must practice daily.
5. Work for high enough arch on the ball to get it into the basket.
6. Execute the movement smoothly with the same rhythm.
7. The most important phase of good shooting is to develop confidence.
8. Keep the fingers of the shooting hand spread, pressure on the ends, to help control the ball.
9. The mental state of the player is the factor which determines the accuracy of a shot in a game situation. Through concentration and conscious thought control, the shooter must erase all else from his mind except that of making the basket.
10. Use the left hand as a guide in the beginning of the shooting action.
11. Keep the eyes focused on your point of aim.
12. To gain more force on the ball: (1) use deeper knee bend; (2) get a faster, more powerful extension of the body and weight upon the right foot.

APPENDIX B

THE TWO-HANDED CHEST PASS[1]

Basic to any system of basketball, the two-handed chest pass is used to make short-distance passes. The mechanics of performance allow such movements as fakes and drives, shots and passes. Include the same principles in teaching the two-handed chest pass as you would for the two-handed chest shot. The accuracy of the flight of the ball in the pass and the shot should not vary as the release of the ball off the hands is very much the same.

Give players the following instructions for effecting the two-handed chest pass:

1. Hold the ball in the fingertips, not the palms or heels of the hands.
2. Place the hands on the side of the ball with the fingers spread comfortably and the thumbs parallel.
3. The hands may be held slightly lower than in the two-handed shot.
4. Keep elbows close to the body to assure relaxation of hands and forearms and to avoid a direct release being made by the thumbs.

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[1]Stan Watts, Developing an Offensive Attack in Basketball. (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1959).

5. Release the ball entirely with arm extension and wrist and finger action, with a slight spin toward the passer after its release.
6. Aim at the chest of the receiver.
7. If the pass is somewhat long, take a step as the ball is released to assure the necessary force. A left-handed player should step with his right foot and a right-handed player should step with his left foot to get proper body balance and force.
8. In both long and short distance two-handed chest passes, check the extension of the arm with the follow-through coming with the wrist and finger action. The palms of the hands will be facing the floor and the arms should be held momentarily in front and not allowed to swing to either side.

VITA

The author was born in Port Barre, Louisiana on November 30, 1932. He received the elementary and high school education in Port Barre, graduating from Port Barre High School in 1951.

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